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ON THE PATHOLOGICAL AND PRACTICAL
RELATIONS OF THE DOCTRINE OF
THE BACILLUS TUBERCULOSIS.

BY

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ON THE PATHOLOGICAL AND PRACTICAL
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THE literature of the last quarter of a century, so far as it relates to pulmonary phthisis, offers a striking example of the mutability of medical opinions, and an instructive lesson for truth-seekers in the field of medicine. About twenty-five years ago, Virchow enunciated the dogma that the name tubercle should be restricted in its application to neoplasms known as miliary tubercles, or the granulations of Boyle; the phthysical products distinguished as infiltrated, crude, yellow, or cheesy tubercle having no claim to be considered as tuberculous. This dogma rested on an exclusively histological basis. It was accepted by many French and British, as well as by most of the German pathologists, and largely in this country. As a consequence, pulmonary phthisis and pulmonary tuberculosis were regarded as essentially distinct affections.

Phthisis, being relegated among the purely inflammatory diseases, received a variety of new names, such as broncho-pneumonia, chronic catarrhal pneumonia, cheesy pneumonia, lobular pneumonia, etc. That phthisis and true tubercles were associated, in a certain proportion of cases, was admitted, and, reversing the teaching of Laennec as regards their relationship, the tubercles, in these cases, were regarded as occurring, not anterior, but secondary, to the phthysical products, being attributed to an

¹ Read at the First Stated Meeting of the New York County Medical Association, January 14, 1884.

auto-infection either from phthysical or degenerating products of some kind, somewhere within the body. Reasoning from these premises, in opposition to the results of the clinical studies of Laennec, Louis, and others, the development of phthisis was attributed often to an extension of inflammation from the bronchial tubes, and, not infrequently, to an antecedent lobar pneumonia. A peculiar predisposition to phthisis, as expressed by the terms diathesis, dyscrasia, and cachexia, was repudiated. A susceptibility to morbid agents of all kinds was alone admitted, under the name vulnerability. As practical consequences, patients affected with phthisis were treated by measures addressed to chronic inflammatory affections. Local bloodletting, counter-irritation, confinement within doors, mercurialization, and restricted diet—measures heretofore in vogue, which had become obsolete because experience had shown them to be hurtful—entered again, to a greater or less extent, into the practice of physicians in cases of phthisis.

These pathological, etiological, and therapeutical views, so widely at variance with those which had been established by the clinical studies of Laennec, Louis, and others, had their origin in the microscopical observations which led Virchow to conclude that an essential distinction exists, as regards the anatomical elements, between the ordinary phthysical products and the bodies to which he restricted the name tubercles.¹ During the greater part of the last quarter of a century, a large share of medical literature, in different countries, has been devoted to investigations and discussions either relating to,

¹ In a recent discussion at a meeting of the Berlin Medical Society, Virchow proposed to distinguish miliary tubercles and caseous hepatization as "bacillary affections." There does not seem to be any intrinsic impropriety in this name, but the unfortunate consequences of his former definition of tubercle do not afford encouragement for another attempt in the way of nomenclature.

or growing out of, the dogma enunciated by Virchow. As a result of these investigations and discussions, the dogma and, of course, all deductions therefrom were at length shown to be erroneous.

It required, thus, nearly twenty-five years to emerge from errors due to a false conclusion from microscopical appearances observed in a pathological laboratory. The errors were not merely of pathological interest, but they influenced unfavorably the treatment of patients affected with phthisis. What is the lesson to be learned from this retrospect? It teaches, of course, the evils of hasty or rash pathological deductions; but I will go further and say that it teaches the importance of the clinical study of diseases as a safeguard against errors arising from exclusive attention to histological researches. Laennec, Louis, and they who followed in their footsteps, were painstaking, careful, and conscientious clinical observers. The fruits of their studies are as valuable to-day as they have been in the past, and they will remain so as long as the diseases which they studied and the human constitution continue unchanged.

In speaking thus of the importance of clinical medicine, I do not undervalue pathological researches. Of the importance of these, the subject of my paper offers a brilliant example.

A notable event in the literature of phthisis was the announcement by Villemin, in 1865, of the inoculability of tubercle. The accuracy of Villemin's experimental observations was speedily established by other observers. But the conclusion that inoculability proved the existence of a specific virus was opposed by experiments which appeared to show that morbid matter evidently not tuberculous, as well as putrescent organic substances, and those even which could have only a mechanical effect, were capable of inducing tuberculous disease in certain animals by inoculation. These apparent ob-

stacles in the way of the recognition of a specific virus had been, in a great measure, if not entirely, removed when the discovery of a particular micro-organism—the bacillus tuberculosis—was announced by Koch in 1882.¹ The latter discovery may be said to be a sequel of that by Villemin.

Two things are remarkable in view of the recency of the announcement of Koch's discovery. It is remarkable that it should have at once excited so much interest in different countries. This has rarely been the case with past discoveries of like novelty as well as importance. It is remarkable that they who have already accepted the discovery are among those who, as practical histologists, are most competent either to confirm or disprove it.

The statement of the fact that a peculiar micro-organism, to which Koch gave the name bacillus tuberculosis, was found by him in tuberculous products, by no means expresses the length and breadth of the discovery. This fact, however, lies at the foundation of a new doctrine—a doctrine apparently in conflict with well-founded pathological truths, and of great practical importance.

Before considering its pathological and practical relations, let us inquire of what does this doctrine consist, and on what does its validity rest? Is the bacillus tuberculosis a veritable micro-organism?

The affirmative answer to this question must be based on the testimony of competent and trustworthy microscopists, and there is almost entire unanimity among these in the conclusion that the bacillus tuberculosis is a veritable micro-organism.

¹ Of those who claimed that tuberculous disease in certain animals may be artificially produced by inoculation with non-tuberculous substances, Cohnheim and Wilson Fox were the most prominent and influential. As showing that, in the minds of these distinguished pathologists, the desire for truth is paramount to the pride of opinion, it is pleasant to state that Cohnheim, prior to Koch's discovery, and Wilson Fox, quite recently, have publicly made avowal that they were mistaken.

Of this, positive proof is the reproduction of the organism by culture outside of the body.

Is the bacillus tuberculosis constantly found in morbid products, which, irrespective of its presence, are known to be tuberculous?

The affirmative answer to this question is sustained by a very general agreement among competent and trustworthy microscopists.

Is the bacillus tuberculosis found in morbid products which otherwise have no claim to be recognized as tuberculous?

So far as I know, an affirmative answer to this question is *not* sustained by the testimony of competent and trustworthy microscopists.

From these data it may logically be concluded that the bacillus tuberculosis is a peculiar parasitic micro-organism which is characteristic of tubercle. But the doctrine goes further. The nature and extent of the pathological connection of the bacillus with tuberculous disease are to be inquired into.

Is the bacillus tuberculosis the causative agent in the development of tuberculous disease?

This is an all-important question as regards the pathological and practical relations of the doctrine. Koch's discovery embraced the induction of tuberculous disease in certain animals by inoculation with the bacillus. In order for inoculability to constitute proof that the organism, *per se*, is the causative agent in the experiments, it is evident that the bacillus must be devoid of any morbid matter which might be adherent to it. This essential requirement is secured by repeated cultivations in a culture-medium out of the body. Koch found that the organism, after it had been carried through several generations, was capable, by inoculation, of inducing tuberculous disease. Assuming accuracy of the observations, this result is demonstrative proof that the bacillus, at least in the experiments on certain animals, is the causative agent in the development of tuberculous disease. The accuracy of

Koch's experimental observations in this regard has not been disproved. Reasoning from analogy, and still assuming the correctness of the data, it is a logical conclusion that pulmonary phthisis, in the human subject, is caused by the presence of this parasitic organism.

This completes the doctrine of the bacillus tuberculosis. It follows therefrom that pulmonary phthisis is an infectious disease, using this term infectious in the sense in which it is at present used by most medical writers, namely, as denoting disease dependent on special causative agents, which, under favorable circumstances, are capable of multiplication indefinitely either within or outside of the body. The multiplication of the special causative agent in phthisis, takes place within the body. The disease is therefore communicable by means of the causative agent, the bacillus. The causative agent, thus, is a *contagium vivum*. If the validity of the doctrine be acknowledged, it must be admitted to be vastly improbable that phthisis is ever developed without the presence of the parasite. It may be laid down as a law in etiology, that the agency of special causes is essential in the development of all infectious diseases, and there is no reason for supposing that phthisis is an exception to this law. Another conclusion must be admitted, namely, that pulmonary phthisis, is primarily a local affection. The initial morbid processes take place in the lungs, being due to the presence of the parasite. The bacilli, doubtless, inhaled with the inspired breath, become colonized within the pulmonary alveoli. They give rise to tuberculization in the situations which they inhabit. The local affection extends in consequence of their invasion, successively, of different parts of the pulmonary organs, and the development of the disease in other situations depends on their migrations.

We are now to consider an apparent antagonism between the doctrine of the bacillus tuberculosis

and certain facts derived from the clinical study of pulmonary phthisis. In view of such an antagonism, what are we to do as seekers after truth? Are we to repudiate the doctrine on the one hand, or the clinical facts on the other hand? We are to do neither the one nor the other. We are to satisfy ourselves of the truth of the doctrine, and that the clinical facts are well grounded; then, the doctrine and the facts are to be reconciled. If the doctrine be true and the facts well grounded, there must be a way of reconciliation. In reality, the antagonism is apparent only, not actual, as I shall endeavor to show. The antagonism relates especially to the existence of a tuberculous diathesis, to the well-established operation of causative agencies other than a contagium, and to a lack of clinical evidence of communicability.

Pulmonary phthisis is eminently a diathetic disease. The diathesis, that is, the predisposition, is evidently in some persons innate. How otherwise are to be explained the instances in which many children in certain families become victims of the disease—instances which are too many to be accounted for on the ground of accidental coincidence? No one who has given any attention to the statistics of this disease, can doubt that heredity is involved in the causation. That the disease is developed much oftener in some climates than in others, is certain, and it is equally certain that, irrespective of climate, insalubrious situations, a humid soil, confinement in illy-ventilated rooms, insufficient alimentation, and mental depression, exert a causative influence. No fact in medicine is better established than that age enters largely into the causation of pulmonary phthisis.

How are these facts to be reconciled with the doctrine which teaches that the efficient causative agent in the development of this disease is a contagium? And, as regards communicability, statistics have failed to prove that this disease is contagious.

It is true that isolated instances seem to point to its communicability, but the analytical study of large collections of recorded cases seem to furnish evidence against, rather than for, contagion. Of those who are brought into close proximity to phthisical patients in hospitals or elsewhere, how small is the proportion who become affected with the disease! At the time of Koch's discovery, there were a few physicians who believed that phthisis might be communicated; but the great majority of the members of the medical profession had no faith in its contagiousness. How are these facts to be reconciled with the doctrine which teaches that phthisis is never developed without the presence of a *contagium vivum*?

The special morbid agents which give rise to infectious diseases require for the efficiency of their causative action certain special concurrent, coöperating conditions within the body. This requirement is greater in some than in other diseases, but the statement is probably applicable to a greater or less extent to all. The special agent is an essential factor; and another, not less essential, is the existence of the requisite concurrent, coöperating conditions. The nature of these conditions is unknown, but the fact of the necessity for their existence in the causation of diseases is as certain as if they were known. We may embrace these conditions under the name predisposition. If the special causative agent be a micro-organism, it is customary to say that, like certain plants, it needs for its growth and multiplication certain peculiarities of soil. The term predisposition embraces these peculiarities. The two factors in the causation, namely, the special causative agent and the concurrent, coöperating conditions embraced under the name predisposition, in their application to yellow fever, were compared by the late Dr. Barton, of New Orleans, to the two blades of a pair of scissors; their efficiency depends

on their being joined together; separated, each is powerless.

The predisposition to pulmonary phthisis involves all causes exclusive of the special causative agent—the bacillus. An innate tendency, heredity, and the other causes already referred to, exert their influence by inducing or promoting the predisposition to the disease. The predisposition is the diathesis. It may be either congenital or acquired. It may exist and afterward disappear. It may probably be removed by measures employed for that end. This last statement is of great practical importance, and will be referred to in another connection. If the predisposition be wanting, persons are insusceptible to the special cause of pulmonary phthisis. However large the number of bacilli inhaled, they are powerless, like the separated blade of a pair of scissors. If the predisposition exist, phthisis will be developed, unless the inhalation of bacilli can be avoided; and this, in most parts of the world, is impossible, so long as the disease is as prevalent as it now is. The susceptibility dependent on the predisposition doubtless varies much in degree in different persons, and at different times in the same person. The danger of contracting the disease, as it is reasonable to suppose, is proportionate to the degree of the susceptibility. It is also a rational supposition that the danger is, in a measure; proportionate to the degree of exposure to the contagion.

The views just presented are not peculiar in their application to tuberculous disease. The susceptibility to this disease, as shown by the results of inoculation, are far from being the same in all animals. It is great, for example, in rabbits, and comparatively slight in dogs. Some persons are insusceptible to the special causes of certain diseases, smallpox included. To certain of the contagious diseases the susceptibility is extinguished if the disease be once experienced. On the other hand, the occurrence of certain diseases (for example, re-

lapsing fever), does not in the least lessen the susceptibility to their causes. Persons may be exposed many times to contagia or other special causes with impunity, the diseases becoming at length developed on exposure. In short, I have applied to pulmonary phthisis well-known truths as applied to other infectious diseases. These truths are novel, and may seem startling in their application to pulmonary phthisis, because, up to the present time, few physicians have been accustomed to look upon this disease as belonging among the infectious diseases.

I proceed to consider briefly the doctrine of the bacillus tuberculosis in its practical relations. In this division of the subject, we are to inquire into the relations of the doctrine to the diagnosis, prognosis, and treatment of pulmonary phthisis.

Of the importance of the bacilli in diagnosis, I can speak from personal knowledge. For several months I have obtained the results of examinations of sputa for bacilli in a large proportion of the cases which have come under my observation in hospital and in private practice. Not claiming to be a microscopist, it is proper to state that these examinations have been made either by my colleague, Prof. William H. Welch, or by my clinical assistant, Dr. William H. Flint, or by Dr. H. M. Biggs, Senior Assistant Physician of the Third Medical Division of Bellevue Hospital. The results taken in connection with the histories, the symptoms, and the physical signs, have satisfied me that the bacilli in the sputa may be relied upon as proof of the existence of tuberculous disease. There is abundant, competent testimony to the correctness of this statement. I am led to believe that, if repeated examinations, made with sufficient care, show the presence of the parasite, the diagnosis of phthisis is positive, and, on the other hand, if, on repeated and careful examinations, bacilli be not found, phthisis may,

with much probability, be excluded. I return to predict that the time will soon come when, in order to corroborate the diagnosis, and as the hinge on which the question of diagnosis will turn in certain cases, microscopical examinations of sputa will be considered to be as much a matter of course as examinations of urine for evidences of renal disease. In cases of suspected phthisis, when the diagnosis is not rendered clear by physical signs, the presence or the absence of bacilli in the sputa will serve to determine either that the disease exists, or that it may be excluded. I could cite many cases which have been under my observation, in illustration of the value of this criterion of pulmonary phthisis.

So far as my experience goes, an abundance of bacilli in the sputa of phthisical patients is evidence of active progress of the disease, and *vice versa*. I am prepared to believe that in the number of bacilli found on repeated examinations, we have important data for forming a judgment in relation to prognosis. I have been much interested in the study of some cases of lesions incident to advanced phthisis, as shown by physical signs denoting solidification of cavities, in which bacilli in the sputa were few or wanting. The results of the microscopical examinations of the sputa in these cases, corresponded with the history and symptoms in showing that the tuberculous disease had ceased, and that the patients suffered only from the lesions resulting therefrom. The bearing of this fact on prognosis is obvious. We may hope for the recovery, or at least, an indefinite prolongation of life in cases of phthisis in which the lungs are considerably damaged, provided the tuberculous processes of disease have ceased. I have enunciated in different publications the conclusion based on my own clinical studies, that pulmonary phthisis is a self-limited disease. The parasitic doctrine is in full accord with this conclusion. After a series of successive generations, the race of bacilli becomes extinct,

probably because the local conditions for further multiplication no longer exist. In this regard, the tuberculous affection resembles other infectious diseases.

Lastly, the relations of the doctrine of the bacillus tuberculosis to the prevention and treatment of pulmonary phthisis, are the most important of the practical aspects of the doctrine.

The prevention of the disease can be effected by the accomplishment of either one of two objects, namely: First, avoidance of all exposure to the contagium; and, secondly, the removal of the concurrent, coöperating conditions in which consists the diathesis, the predisposition, or the susceptibility.

The first of these objects is not easily accomplished. Wherever there are cases of phthisis, the respired atmosphere may contain bacilli. We may be at this moment inhaling them if, among this audience, there are persons affected with phthisis. If there be a spot on the globe where there is not, and has never been, a case of phthisis, in that spot a person—no matter how great may be the predisposition—is safe. But where among the places in which persons may wish to live is such a spot to be found? It is evident that prevention by this method cannot be reduced to a degree approaching to certainty. Perhaps as safe a situation as any, exclusive of uninhabited regions, is on shipboard, provided it is certain that all others on board are free from phthisis. But we cannot enjoin on healthy persons to spend their lives at sea, especially inasmuch as we have no positive criteria of a tuberculous predisposition prior to the development of phthisis.

Preventive measures, moreover, relating to this object are not to be ignored. Assuming the existence of a tuberculous predisposition, there may be more or less exposure to the contagium, and the disease be not developed, the bacilli failing to become colonized. Exposure to the contagia of other diseases, or to infectious matter multiplied outside of

the body, is by no means always followed by infection. Danger of infection is, of course, other things being equal, proportionate to the degree and duration of exposure. Hence, preventive measures, in this direction, are to be employed as far as practicable. Healthy persons should not occupy the same bed with phthisical patients, nor the same room at night, unless the dictates of duty, humanity, or affection, require that the risk of infection should be incurred. Sanitaria for phthisical patients and situations considered as favorable for those patients, should be avoided by those who are not tuberculous, in their choice of health resorts. The disinfection of sputa from phthisical patients by some simple but effective means is to be recommended. The freest possible ventilation of rooms or hospital wards occupied by phthisical patients should be secured. It is probable that not a little can be accomplished, in the way of prevention, by proper attention to these points.

The prevention of phthisis by the removal of the predisposition is a more available method. Here we labor under the difficulty of not being able to recognize with positiveness, by any criteria as yet ascertained, the existence of the tuberculous predisposition. Its existence should certainly be suspected if brothers or sisters have died with phthisis, and whenever there is reason to suppose that the predisposition may be inherited. Especially are preventive measures in this direction to be employed during the period of life when the disease is most apt to be developed, namely, from twenty to thirty years of age. Evidently, if preventive measures be practicable, it is far better to be oversuspicious of the tuberculous predisposition than to err in not having suspicion sufficiently aroused.

Ignorance of the particular conditions which constitute the predisposition to phthisis, is to be confessed, and we must, therefore, be guided by the lessons of experience and of common sense in the

endeavors to remove this predisposition. These lessons teach that a dry, salubrious, uniform climate, the atmosphere rarefied by altitude, ample alimentation, life in the open air, a fair proportion of muscular exercise, protection of the surface of the body from cold, and cheerful spirits, are measures to be relied upon for this object. The measures, in other words, are those which tend to produce the highest grade of constitutional vigor. It is certain that the prevalence of phthisis would be greatly diminished by these measures; and if every member of the human family could be made to enjoy in the utmost degree the blessings of hygiene, who knows but that, in the course of time, the complete extinction of this disease might be included among the triumphs of preventive medicine.

The treatment for the arrest of pulmonary phthisis has reference to two objects: first, the destruction of the parasite, and, second, the removal of the conditions on which it depends for its existence.

Although not quite two years have passed since the announcement of Koch's discovery, many experimental observations have been made with a view to discover an effectual parasiticide which will destroy the bacilli by direct contact, either by means of inhalation, or by introduction into the circulatory system. Various substances which are known to be destructive to micro-organisms outside of the body, have been employed, such as corrosive sublimate, iodoform, bromine, arsenious acid, salicylate of soda. Thus far they have proved ineffectual.¹

There are three difficulties in the way of success

¹ MM. Parrot and Martin have reported in the *Revue de Médecine* (Nos 9 and 10, 1883) the results of experiments with a view to discover a parasiticide which will be effectual without injuring the tissues. They found that salicylic acid, sulphate of quinine, corrosive sublimate, carbolic acid, creasote, bromine water, and peroxide of hydrogen, in quantities suitable for administration, have no influence on the bacillus. *Vide THE MEDICAL NEWS*, December 22, 1883.

by means of inhalation. The first is to discover the particular parasiticide. This difficulty applies alike to both methods of effecting the destruction of the parasite by direct contact. Of the different infectious diseases supposed to depend on the presence of micro-organisms, each has its own parasiticide. Mercury, for example, is an effective agent in cases of syphilis, but it has no effect upon malarial disease; and the specific agent for the latter is without effect in syphilis. For most of the infectious diseases, the specific curative agents remain to be ascertained. The second difficulty in the way of the direct destruction of the parasite by means of inhalation is, that the agent for its destruction, inhaled in the form of either an impalpable powder, a vapor, or a gas, is not likely to reach the colonies of bacilli in sufficient quantity to effect the object. The third difficulty is, that a parasiticide brought into direct contact with the bacilli by means of inhalation, in sufficient quantity to destroy them, is likely to injure the tissues, or, by passing into the blood, to induce toxæmia.

The two last-named difficulties do not apply to the introduction of parasitides into the blood. It remains to be ascertained by experimental observations which, as yet, are but commenced, whether a parasiticide can be found capable of effecting the first object in the treatment, namely, the direct destruction of the parasite, by means of either its inhalation or its introduction into the circulation. That this object may be effected, is by no means beyond the limits of possibility, nor, perhaps, of probability. For this we must wait patiently. Meanwhile, the second object in the treatment, namely, the removal of the conditions on which the parasite depends for its existence, is not to be overlooked, nor undervalued.

Let it be borne in mind that the continuance, as well as the origin, of pulmonary phthisis, depends on two factors—the presence of bacilli and the con-

current, coöperating conditions. The disease will cease to progress whenever either factor ceases to exist. Without the conditions just named, the generation of bacilli must end. Without bacilli, there can be no tuberculosis. The bacilli are destroyed by removing the conditions on which their existence depends, as surely as by an effective parasiticide. Applying, in the plural number, the language of Shylock, "you take their lives when you do take away the means by which they live." The measures for the removal of these conditions are precisely those pertaining to hygiene, which enter into the preventive treatment, and they need not be here recapitulated.

In conclusion, I will summarize an estimate of the pathological and practical relations of the doctrine of the bacillus tuberculosis, at the present moment, by quoting the concluding paragraph of another article :

"The researches of Koch and others have extended our knowledge of the pathology and etiology of pulmonary phthisis. Their practical bearings on diagnosis and prognosis are important, and they have opened up inquiries in relation to prophylaxis which may lead to useful results. But, as regards hygienic and medicinal agencies in the treatment of the disease, we have thus far acquired nothing beyond the rational views and the lessons of experience by which physicians were guided prior to the discovery of the bacillus tuberculosis. These views and lessons remain unaffected by the discovery. In the adaptation to individual cases of phthisis, of remedies, diet, regimen, and climatic changes, we are to continue in the endeavor to judge by the light of reason and experience; and it is not less a duty now than heretofore to accumulate facts which have practical bearings, irrespective of any doctrine."¹

¹ *Vide* Appendix to A Treatise on the Principles and Practice of Medicine, by the writer. Fifth edition, 1883.



